

# PATENT SPECIFICATION

595,908



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Complete Specification Accepted: Dec. 23, 1947.

## PROVISIONAL SPECIFICATION

### Improvements in or relating to the Forming of Undercut Holes

We, THE BRITISH UNITED SHOE MACHINERY COMPANY LIMITED, a British Company registered under the Companies Acts, 1862—1898 and JAMES 5 NORMAN HENSHAW, British Subject, both of Union Works, Belgrave Road, in the City of Leicester, do hereby declare the nature of this invention to be as follows:—

10 This invention is concerned with improvements in or relating to the forming of undercut holes. While the invention has been devised especially in connection with the forming of undercut 15 holes for use in riveting and will, by way of example, be hereinafter described in connection with riveting, yet it is to be understood that the invention is not limited thereto but may find application 20 in connection with the forming of undercut holes for other purposes.

It is well known to rivet parts together by so-called "pop" riveting, in which process there is threaded into aligned 25 holes in the parts a hollow rivet itself threaded on a mandrel having a head larger than the bore of the rivet though smaller than the holes in the parts, the rivet being set by pulling on the stem 30 of the mandrel, where it projects through the head of the rivet, while holding the head of the rivet up to the work. Such a process is most commonly employed for the riveting together of parts of sheet 35 material of combined thickness less than the length of the rivet stem but it is also known to employ it for securing a relatively thin part to a much thicker part, the hole in the latter then being a blind 40 hole which does not pass through the full thickness. In such case the tail end portion of the rivet is expanded by the mandrel in the blind hole and provision must be made to enable the expanded rivet to 45 secure itself in the blind hole, one expedient for this purpose being to give the surface of the blind hole a threaded formation as described in the specification of Letters Patent No. 507,358. 50 Another expedient is, however, to provide the blind hole with an undercut formation to receive the expanded part of the rivet and this enables very satis-

factory riveting results to be obtained. It is, in this connection clearly desirable 55 that the undercutting of the holes should be capable of being effected in a simple and convenient manner and it is one of the various objects of the invention to provide an improved method for this purpose, 60 and means suitable for use in carrying out such method.

In accordance with one of its several features the present invention provides a method of forming an undercut hole in a 65 workpiece which comprises causing a tool to enter a preformed hole (which is cylindrical or substantially so) in the workpiece, said tool having a stem (which is substantially less in lateral dimension 70 than the diameter of the hole) and a cutting head which has a lateral dimension larger than the said stem, moving the tool into the hole without effecting cutting (or any substantial cutting) of the 75 wall of the hole, and then causing guide means to enter the hole and, by contacting with the entering end portion of the hole, to effect such lateral shift of the tool that the cutting head is caused to form an 80 undercut portion in the wall of the hole.

In accordance with another of its several features the invention provides a device adapted to form an undercut portion in a hole in a workpiece comprising 85 (a) a rotary tool having a stem and a cutting head which has a lateral dimension larger than the stem, (b) means for causing rotation of the tool and (c) a guide member which does not partake of rotary 90 movement of the tool but which is arranged to enter the hole with the tool (after the cutting head has passed into the hole) and by contacting with the entering end portion of the hole to effect 95 such lateral shift of the tool that the cutting head forms an undercut portion in the wall of the hole.

The above and others of the various objects and several features of the invention will become clear from the description which is now given, with reference to the accompanying drawings, of one convenient method (provided by the invention and illustrative of the method 100 aspects of the invention) and of con-

venient forms of devices suitable for use in the illustrative method (such devices being illustrative of the apparatus aspects of the invention).

5 It is, however, to be understood that such method and devices are selected for description not by way of limitation of the invention but only by way of exemplification of the invention.

10 In the accompanying drawings:

Figure 1 is a view of the operative end portion of one illustrative tool when it has advanced part way along the axial length of a preformed cylindrical hole in

15 a workpiece and before it has begun its undercutting operation;

Figure 2 is a view similar to Figure 1 but showing the tool when it has completed the undercutting operation;

20 Figure 3 shows a hollow rivet, in which a mandril is threaded, which has been inserted in the undercut hole in the workpiece shown in Figure 2 and also through a hole in another workpiece which is to be riveted to the first workpiece, the rivet being illustrated before it has been set;

Figure 4 shows diagrammatically the rivet of Figure 3 after it has been set;

Figure 5 shows part of the supporting 30 and driving means for a tool as seen in Figures 1 and 2;

Figure 6 is a view, on a larger scale than Figures 1 and 2, of the cutting head of the tool shown in those Figures;

35 Figure 7 is another view of the cutting head seen in Figure 6, but looked at at right angles to the direction in which it is viewed in Figure 6;

40 Figure 8 is another view of the cutting head seen in Figures 6 and 7, looked at from beyond its end in a direction axially of the tool;

Figure 9 is a view similar to Figure 6 but showing another illustrative tool the 45 shape of the cutting head of which is modified as compared with the shape shown in Figure 6;

Figure 10 is another view of the cutting head seen in Figure 9, looked at from beyond its end in a direction axially of the tool:

55 Figures 11, 12 and 13 are views respectively corresponding to Figures 6, 7 and 8 but showing a further illustrative tool having a modified shape of cutting head; and

Figures 14 and 15 are views respectively corresponding to Figures 6 and 7 but showing yet another illustrative tool having a modified shape of cutting head.

60 Referring to Figures 1, 2, 5, 6, 7 and 8 the illustrative tool therein shown comprises a stem 1 and a cutting head 3 which at one side projects laterally 65 beyond the stem. The stem 1 is

clamped in a rotating chuck 5 of a suitable portable apparatus, for example a portable electric drilling apparatus. The stem 1 also passes through a sleeve 7 which is rigidly supported by a bracket 8 fixed to the casing of the apparatus. The sleeve 7 has a tapered portion 9 which is separated by a short distance from the cutting head 3. Figure 1 shows the tool entered part way into a cylindrical hole 11 which has been previously drilled in a workpiece 13 (for example, a metal bar). As seen in that Figure the stem 1 of the tool is of a size substantially less than the diameter of the hole 11 but the lateral dimension of the cutting head 3 is substantially equal to the hole diameter, though the tool is relieved slightly at one side as shown at 15. The tool may be entered to the position shown in Figure 75 1 before being caused to rotate or it may be rotating as it moves to the Figure 1 position, in which latter case the apparatus will be loosely supported in the hands of the operator so that it (including 80 the sleeve 7) will have a gyratory movement about the axis 17 of the hole, this movement resulting from the fact that at this stage the cutting head has no such lateral thrust imposed upon it as to effect 85 cutting (or any substantial cutting) despite the fact that the axis 19 of the stem 1 is offset from the axis 17. In Figure 1 the tapered portion 9 of the sleeve 7 is just about to enter the hole 100 11 and when it does so it bears against the entrance of the hole and, as the tool advances, progressively restricts the permitted amount of the aforesaid gyratory movement of the sleeve 7 until, as seen in 105 Figure 2, it finally constrains the tool to occupy the position in which the axis of the stem of the tool is coincident with the axis of the hole 11. During the motion between the Figure 1 and Figure 110 2 positions the lateral thrust imparted to the rotating tool as a result of the tapered sleeve 7 entering the hole causes the cutting head 3 to operate to form an undercut portion 21 in the wall of the 115 hole, this undercut portion tapering outwardly, in a direction away from the entrance of the hole, to a part of maximum diameter. The tool is then withdrawn.

120 Referring to Figures 3 and 4, it will be assumed that it is desired to rivet a member 23 to the workpiece 13. A suitable hole is formed in the member 23 and a hollow rivet 25, having a headed 125 mandril 27 threaded therein, is inserted through this hole into the undercut blind hole 11. The head 29 of the rivet is then held up tightly against the member 23 by the nose of a rivet setting tool of known 130

type which also has means for gripping the stem of the mandril 27 and imparting a rivet setting pull thereto. This pull on the mandril causes the head 31 of the mandril to be drawn into the tail end of the rivet to expand the latter tightly into the undercut portion 21 of the hole 11, thereby to cause the rivet to be firmly locked in set position. The mandril 27 is shown as being of the so-called "break stem" type, it having a constriction 33 in its stem at which it is arranged to break when the setting of the rivet has been accomplished, leaving the broken-off head 15 portion of the mandril firmly retained in the set rivet.

As shown more particularly in Figures 6, 7 and 8, the cutting head 3 has an inclined flat portion 35 at each side thereof and has ground faces 37 and 39 which provide backed-off cutting edges 41 and 43. In the slightly modified tool shown in Figures 9 and 10, there are ground faces 37<sup>1</sup> and 39<sup>1</sup>, which provide cutting edges 41<sup>1</sup> and 43<sup>1</sup> which are rather more inclined to each other than the edges 41 and 43. In this cutting head the greater inclination of the edge 41<sup>1</sup> to a

line parallel to the axis of the tool (as compared with the inclination of the edge 30 41) provides, as is desirable in some cases, that the cutting action is initially localised more to the corner portion where the edges 41<sup>1</sup> and 43<sup>1</sup> meet.

Another form of tool cutting head, 35 suitable for use as hereinbefore described with reference to Figures 1 and 2, is shown in Figures 11, 12 and 13. In this form there are cutting edges 45 and 47 and the cutting head has a flattened portion 49 at one side only thereof and is somewhat more robust than the cutting heads shown in the earlier figures, since there is more metal behind the cutting edges. The form of cutting head shown 45 in Figures 14 and 15 comprises cutting edges 51 and 53 which are arranged at a modified angle as compared with the edges 45 and 47. The cutting head of Figures 14 and 15 has, like the cutting 50 head of Figures 11, 12 and 13, a flattened portion 55 at one side only.

Dated this 6th day of July, 1945.

A. S. GRAY,  
Chartered Patent Agent,  
160, Belgrave Road, Leicester.

#### COMPLETE SPECIFICATION

##### Improvements in or relating to the Forming of Undercut Holes

We, THE BRITISH UNITED SHOE MACHINERY COMPANY LIMITED, a British Company registered under the Companies Acts, 1862-1898, and JAMES NORMAN HENSHAW, British Subject, both of Union Works, Belgrave Road, in the City of Leicester, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:-

This invention is concerned with improvements in or relating to the forming of undercut holes. While the invention has been devised especially in connection with the forming of undercut holes for use in rivetting and will, by way of example, be hereinafter described in connection with rivetting, yet it is to be understood that the invention is not limited thereto but may find application in connection with the forming of undercut holes for other purposes.

It is well known to rivet parts together by a blind rivetting process, in which process there is threaded into aligned holes in the parts a headed hollow rivet itself threaded on a mandril having a head larger than the bore of the rivet but smaller than the holes in the parts, the rivet being set by pulling on the stem of the mandril, where it projects from the

head of the rivet, while holding the head 85 of the rivet up to one of the parts to be riveted. Such a process is most commonly employed for rivetting together parts of sheet material of combined thickness less than the length of the rivet stem, 90 but it is also known to employ it for securing a relatively thin part to a much thicker part, the hole in the latter part then being a blind hole which does not pass through its full thickness. In such 95 a case, an end portion of the stem of the rivet is expanded, by the mandril, within the blind hole and it is desirable, in most instances, that provision should be made to enable the expanded rivet to secure 100 itself firmly in the blind hole, one expedient for this purpose being to give the blind hole an internally screw-threaded formation as described in specification No. 507,358. Another expedient 105 is, however, to provide the blind hole with an undercut portion to receive the expanded portion of the stem of the rivet and this enables very satisfactory riveting results to be obtained. It is, in this 110 connection, clearly desirable that the formation of undercut holes should be capable of being effected in a simple and convenient manner, and it is one of the various objects of the present invention to 115 provide an improved method of forming

an undercut hole; it is another of the various objects of the present invention to provide a device adapted for use in carrying out this improved method.

- 5     In accordance with one of its several features, the present invention provides a method of forming an undercut hole which comprises causing a rotary tool to enter a preformed hole (which is of circular or substantially circular cross-section) in the work, said tool being mounted for rotation about the axis of a bearing in a device (of which device the tool forms part) and comprising (a) a stem (which is substantially less in lateral dimensions than the diameter of the hole at the entering end of the latter) and (b) a cutting head which extends further from said axis than does the stem, the tool being entered 10 into the hole without effecting cutting (or any substantial cutting) of the work, and then causing a guide member to enter the hole, and, by engagement with the work at the entering end of the hole, to effect 15 such lateral displacement of said axis that the cutting head is caused to form an undercut portion within the hole.
- 20    In accordance with another of its several features, the invention provides a device adapted to form an undercut portion within a hole comprising (a) a rotary tool, (b) means for causing rotation of the tool about the axis of a bearing of the device, the tool comprising a stem and a cutting head which extends further from said axis than does the stem, and (c) a guide member arranged to enter the hole after the cutting head has been entered 25 into the hole, and, by engagement with the work at the entering end of the hole, to effect such lateral displacement of said axis that the cutting head is caused to form an undercut portion within the hole.
- 30    The above and others of the various objects and the several features of the invention will become more clear from the description which is now given, with reference to the drawings accompanying 35 the provisional specification, of one convenient method of forming an undercut hole (which method is provided by the invention and illustrative of the invention from a method aspect) and of a device 40 which is illustrative of the invention from a device aspect and is used in carrying out the said illustrative method. It is, however, to be understood that the illustrative method and illustrative device are selected 45 for description not by way of limitation of the invention but only by way of exemplification of the invention.
- 50    The several features of the invention are respectively set out as claims Nos. 1 55 and 2.

In the drawings accompanying the provisional specification:

Figure 1 is a view showing one form of tool with which the illustrative device may be equipped; this tool is shown when 70 it has advanced part way along the axial length of a preformed cylindrical, or substantially cylindrical, hole in a workpiece and before it has begun the formation of an undercut portion within the 75 hole;

Figure 2 is a view similar to Figure 1 but showing the tool when it has completed the formation of an undercut portion within the hole;

Figure 3 shows a hollow rivet, in which a mandrel is threaded, which has been inserted into the undercut hole in the workpiece shown in Figure 2 and also through a hole in another workpiece 85 which is to be riveted to the first workpiece, the rivet being illustrated before it has been set;

Figure 4 shows diagrammatically the rivet of Figure 3 after it has been set; 90

Figure 5 shows part of the illustrative device, including means for supporting and rotating the tool shown in Figures 1 and 2; in this figure the tool is shown diagrammatically only;

Figure 6 is a view, on a larger scale than Figures 1 and 2, of the tool shown in those figures, showing its cutting head in detail;

Figure 7 is another view of the cutting head seen in Figure 6, but viewed from a direction at right angles to that from which it is viewed in Figure 6;

Figure 8 is another view of the cutting head seen in Figures 6 and 7, viewed from a direction extending axially of the tool;

Figure 9 is a view similar to Figure 6 but showing another form of tool with which the illustrative device may be equipped in place of that shown in 110 Figures 1, 2, 5, 6, 7 and 8, and the cutting head of which is of a modified shape as compared with the shape of the cutting head shown in Figure 6;

Figure 10 is another view of the tool 115 shown in Figure 9, viewed from a direction extending axially of the tool;

Figures 11, 12 and 13 are views respectively corresponding to Figures 6, 7 and 8 but showing another form of tool with 120 which the illustrative device may be equipped in place of that shown in Figures 1, 2, 5, 6, 7 and 8; and

Figures 14 and 15 are views respectively corresponding to Figures 6 and 7 125 but showing yet another form of tool with which the illustrative device may be equipped in place of that shown in Figures 1, 2, 5, 6, 7 and 8.

Figures 1, 2, 5, 6, 7 and 8 of said draw- 130

ings show one form of tool with which the illustrative device may be equipped. This tool comprises a substantially cylindrical stem 1 and a cutting head 3. The 5 stem 1 is secured in a rotary chuck 5 by which it may be rotated about its axis (shown at 19). The chuck 5 is driven by a portable electric motor of conventional type (not shown) which forms part of the 10 illustrative device. The stem 1 passes through a sleeve 7 which is supported by a bracket 8 fixed to the housing of the motor, the sleeve and stem being coaxial or substantially so and the sleeve acting 15 as a bearing for the stem. The sleeve 7 may be supported on the bracket 8 rigidly or so as to be capable of free rotation relative thereto. The sleeve 7 has a tapered portion 9 which is separated by a short 20 distance from the cutting head 3, the portion 9 having a frusto-conical surface. Figure 1 of said drawings shows the tool after it has been entered part way, as a first step in carrying out the illustrative 25 method, into a cylindrical or substantially cylindrical blind hole 11 which has been previously drilled in a workpiece 13 (for example, in a metal bar). As shown in that Figure, the stem 1 is substantially 30 less in lateral dimensions than the diameter of the hole 11 while the cutting head 3 extends further from the axis 19 than does the stem 1 itself and has a lateral dimension (i.e. a dimension trans- 35 verse to the axis 19) which is larger than the stem, being substantially equal to the hole diameter. The tool is, however, relieved slightly at one side as shown at 40 15. The tool may, in carrying out the illustrative method, be entered into the hole 11 up to the position shown in said Figure 1 before being caused to rotate or it may be rotating as it is moved to this position. In either case the illustrative 45 device will be loosely supported in the hands of the operator so that parts, at least, of it may undertake a very small gyratory movement about the axis 17 of the hole 11 when the tool is rotating; it 50 will be realised that the diameter of the hole 11 will customarily be of the order of  $5/32$  of an inch. No, or no substantial cutting of the workpiece takes place as the tool is entered into the hole 11 up to 55 the position shown in said Figure 1.

As a second step in carrying out the illustrative method, the tool is set in rotation, if this has not already been done, and the tapered portion 9 of the 60 sleeve 7 is entered into the hole 11. As this is done, the portion 9 engages the workpiece 13 at the entering end of the hole 11 (viz. at the upper end as viewed in said Figure 2), and by so doing, as the 65 tool advances, acts as a guide member and

progressively restricts the permitted amount of the aforesaid gyratory movement displacing the common axis 19 of the stem 1 and sleeve 7 laterally until, as seen in said Figure 2, it finally causes the axis 19 to occupy a position in which it is coincident with the axis 17 of the hole 11. During this lateral displacement of the axis 19 the cutting head 3 is caused to form an undercut portion 21 within the hole 11, this undercut portion tapering outwardly, in a direction away from the entering end of the hole 11, to a part of maximum diameter. The tool is then withdrawn.

Referring to Figures 3 and 4 of said drawings, it will be assumed that it is now desired to rivet a relatively thin plate 23 to the workpiece 13. A suitable hole is formed in the plate 23 and a headed hollow rivet 25, having a headed mandril 27 threaded therein, is inserted through this hole into the blind hole 11 which is now undercut. The head 29 of the rivet 25 is then held up against the plate 23 by a nose of a rivet-setting tool of known type which also has means for gripping the stem of the mandril 27 and imparting a rivet setting pull thereto. This pull on the mandril causes the head 31 of the mandril to be drawn into the end portion of the stem of the rivet 25 to expand the latter tightly into the undercut portion 21 of the hole 11, thereby to cause the rivet to be firmly secured in set position. The mandril 27 is of the so-called "break stem" type, it having a constriction 33 in its stem at which it is arranged to break when the setting of the rivet 25 has been accomplished, leaving a broken-off portion of the mandril firmly retained in the set rivet.

The cutting head 3 is shown in more detail in Figures 6, 7 and 8 of said drawings. It has an inclined flat portion 35 at each side thereof and has ground faces 37 and 39 which provide backed-off cutting edges 41 and 43. Another form of tool with which the illustrative device may be equipped in place of that shown in Figures 1, 2, 5, 6, 7 and 8 of said drawings is shown in Figures 9 and 10 of said drawings, the cutting head of this form of tool having ground faces 37<sup>1</sup> and 39<sup>1</sup>, which provide cutting edges 41<sup>1</sup> and 43<sup>1</sup> which are rather more inclined to each other than the edges 41 and 43. In this cutting head there is greater inclination of the edge 41<sup>1</sup> to a line parallel to the axis 19 (as compared with the inclination 125 of the edge 41) so that, as is desirable in some cases, the cutting action is initially localised more where the edges 41<sup>1</sup> and 43<sup>1</sup> meet.

Another form of tool with which the 130

illustrative device may be equipped in place of that shown in Figures 1, 2, 5, 6, 7 and 8 of said drawings is shown in Figures 11, 12 and 13 of said drawings. This form comprises a cutting head having cutting edges 45 and 47; it has a flattened portion 49 at one side only thereof and is somewhat more robust than the cutting head of the forms of tool previously described since there is more metal behind the cutting edges.

Another form of tool with which the illustrative device may be equipped in

place of that shown in Figures 1, 2, 5, 6, 7 and 8 of said drawings is shown in Figures 14 and 15 of said drawings and comprises a cutting head having cutting edges 51 and 53 which are arranged at a modified angle as compared with the edges 45 and 47. The cutting head of said Figures 14 and 15 has, like the cutting head of said Figures 11, 12 and 13, a flattened portion 55 at one side only.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of forming an undercut hole which comprises causing a rotary tool to enter a preformed hole (which is of circular or substantially circular cross-section) in the work, said tool being mounted for rotation about the axis of a bearing in a device (of which device the tool forms part) and comprising (a) a stem (which is substantially less in lateral dimensions than the diameter of the hole) at the entering end of the latter and (b) a cutting head which extends further from said axis than does the stem, the tool being entered into the hole without effecting cutting (or any substantial cutting) of the work, and then causing a guide member to enter the hole, and, by engagement with the work at the entering end of the hole, to effect such lateral displacement of said axis that the cutting head is caused to form an undercut portion within the hole.

2. A device adapted to form an undercut portion within a hole comprising (a)

a rotary tool, (b) means for causing rotation of the tool about the axis of a bearing of the device, the tool comprising a stem and a cutting head which extends further from said axis than does the stem, and (c) a guide member arranged to enter the hole after the cutting head has been entered into the hole, and, by engagement with the work at the entering end of the hole, to effect such lateral displacement of said axis that the cutting head is caused to form an undercut portion within the hole.

3. A device according to Claim No. 2 wherein said bearing is provided by a sleeve through which the stem of the tool passes.

4. A device according to Claim No. 3 wherein said guide member is constituted by a tapered portion of the sleeve.

5. A device according to Claim No. 4 wherein said means for causing rotation of the tool comprises a portable electric motor arranged to drive a chuck in which the tool is secured, and wherein said sleeve is supported on a housing of the motor.

6. A device according to Claim No. 5 wherein said sleeve is supported on the housing so as to be capable of free rotation relative thereto.

7. A method according to Claim No. 1 when carried out by the use of a device according to Claim No. 4.

8. A device according to Claim No. 4 constructed, arranged and adapted to operate substantially as hereinbefore described with reference (a) to Figures 5, 6, 7 and 8; (b) to Figures 5, 9 and 10; (c) to Figures 5, 11, 12 and 13; or (d) to Figures 5, 14 and 15, of the drawings accompanying the provisional specification.

9. A method according to Claim No. 1 when carried out substantially as hereinbefore described and by the use of a device according to Claim No. 8.

Dated this 5th day of July, 1946.

A. S. GRAY,  
Chartered Patent Agent,  
160, Belgrave Road, Leicester.

[This Drawing is a reproduction of the Original on a reduced scale.]

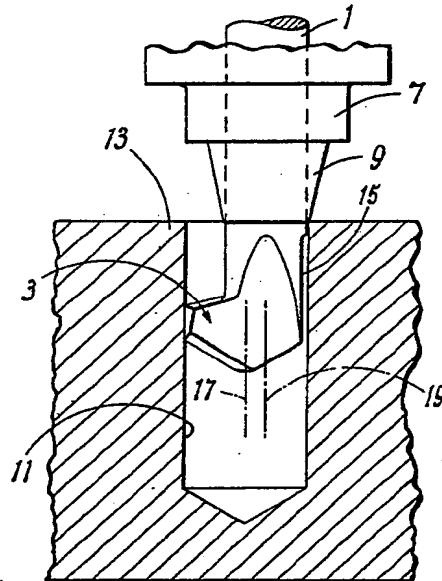


Fig. 1

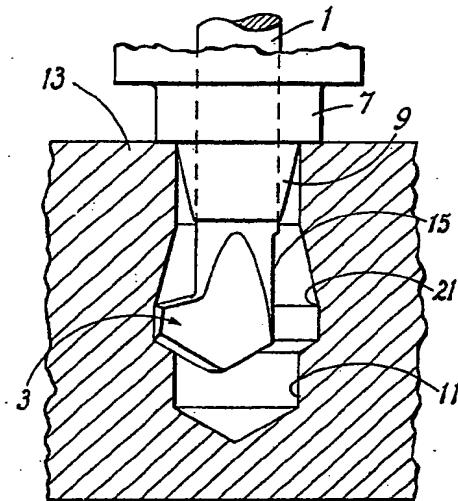


Fig. 2

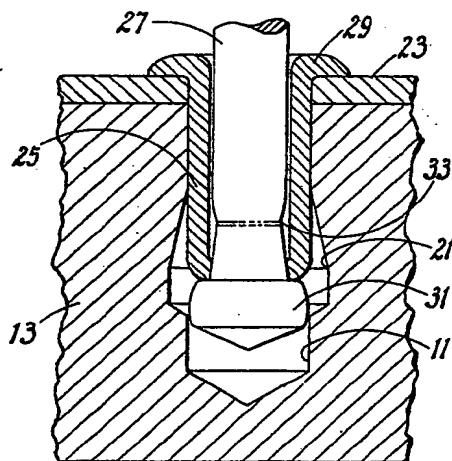


Fig. 3

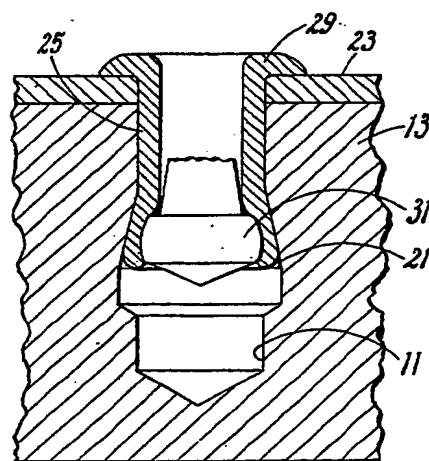


Fig. 4

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SHEET 2

*[This Drawing is a reproduction of the Original on a reduced scale.]*

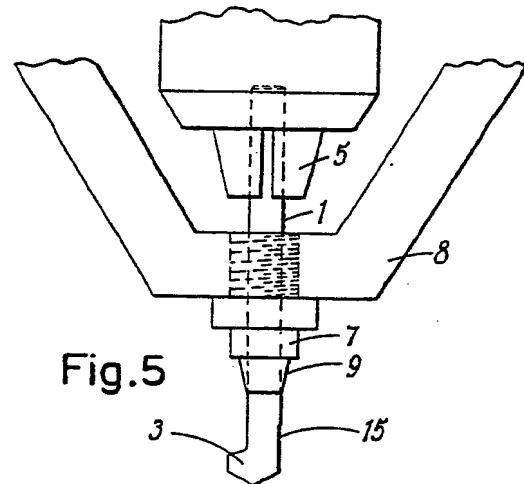


Fig. 5

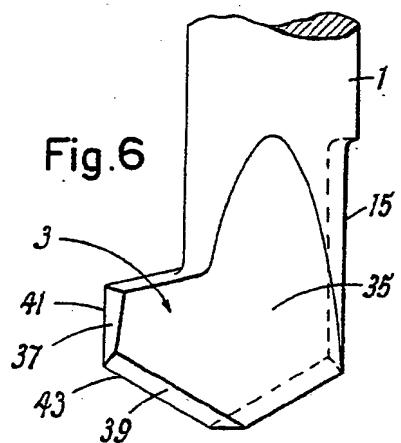


Fig. 6

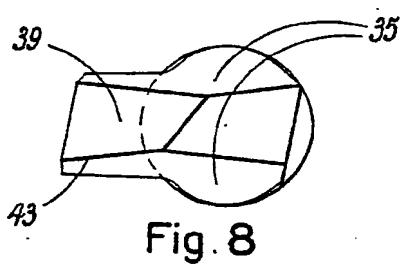


Fig. 8

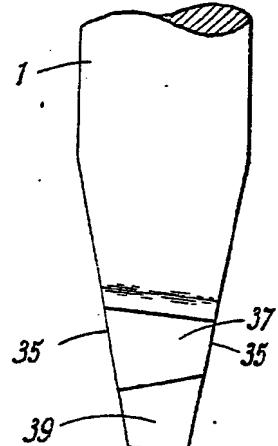


Fig. 7

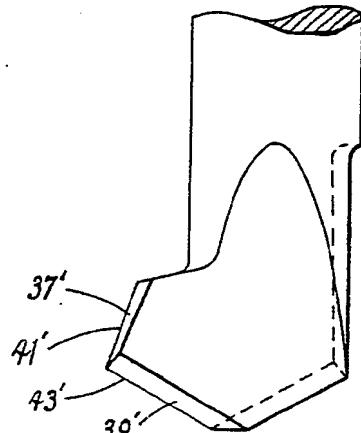


Fig. 9

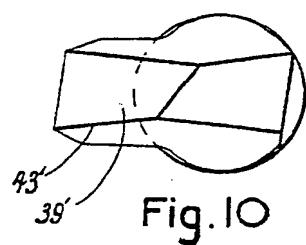
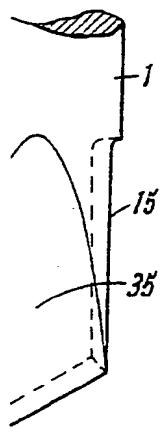


Fig. 10

SHEET 2



7



10

Fig. 11

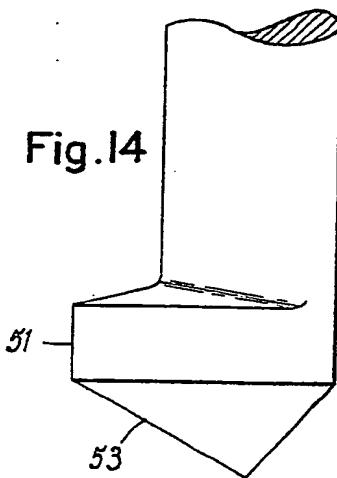


Fig. 14

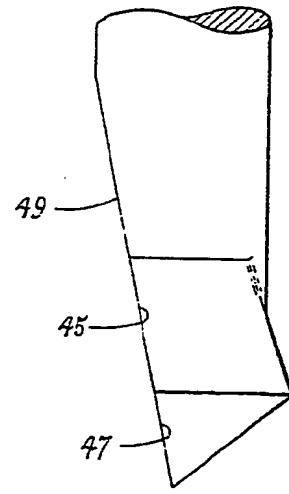


Fig. 15

3 SHEETS  
SHEET 3

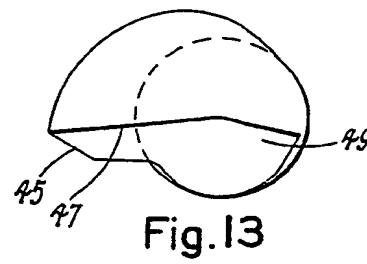


Fig. 13

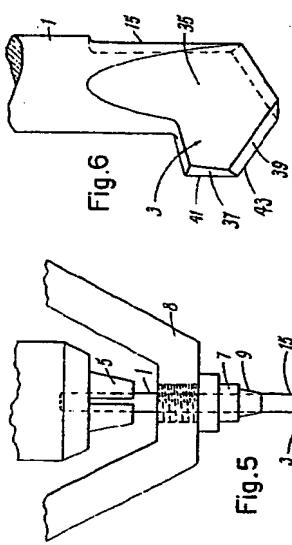


Fig. 5

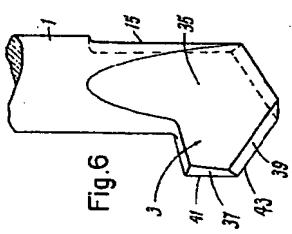


Fig. 6

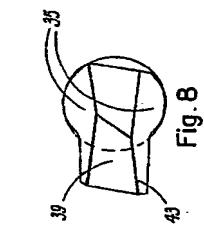


Fig. 7

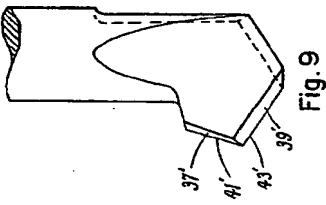


Fig. 8

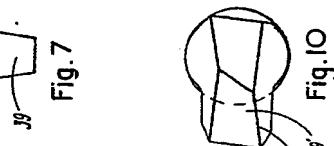


Fig. 9

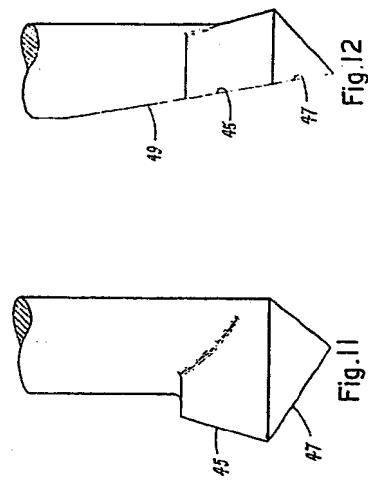


Fig. 11

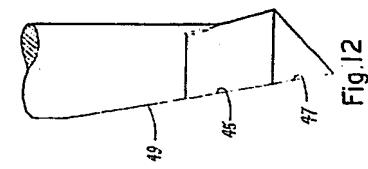


Fig. 12

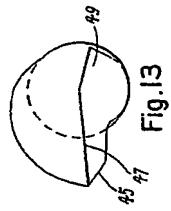


Fig. 13

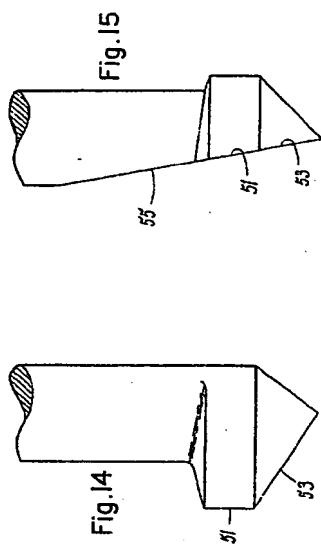


Fig. 14

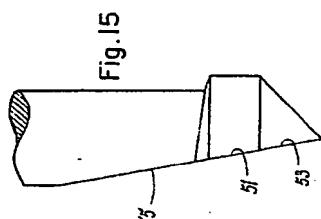


Fig. 15

[This Drawing is a reproduction of the Original on a reduced scale]